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## SYNOPSIS OF NORTH-AMERICAN INVERTEBRATES.

### VI. THE ASTACIDÆ OF NORTH AMERICA.

W. P. HAY.

THE following synopsis of the genera *Astacus* and *Cambarus* will be found to include all the valid species reported from the whole continent of North America.

The crayfishes, our largest and most conspicuous fresh-water crustaceans, are well known to every student of animal morphology. They occur in abundance in most lakes and streams, and, with the exception of the New England States and the Great Plains region, most localities will be found to support several species. They are especially abundant, individually and as species, in the southern and central portions of the United States.

In form, size, armature, color, and habits there is the greatest variation among the seventy-nine species and subspecies now recognized in the genus *Cambarus* and the five known species of *Astacus*. Moreover, almost every species is liable to show the most perplexing variations beyond those depending upon age and sex. On this account the identification of many species becomes exceedingly difficult, and in some cases is possible only when a set of type specimens is at hand. It is thought, however, that a careful use of the synopses given will enable even a beginner to identify with accuracy all but the most puzzling species. In the first list the natural groups are given with the characters distinguishing them, and the geographical distribution of each species is roughly indicated. The second list is a purely artificial key, based upon trenchant characters, by which any specimen, male or female, may be identified.

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## LIST OF SPECIES WITH DISTRIBUTION.

## ASTACUS,

Distribution limited to the Pacific watershed.

*A. gambelli*, Utah, Idaho, Montana.

*A. nigrescens*, San Francisco to Alaska (near coast).

*A. leniusculus*, Columbia R.

*A. trowbridgii*, Columbia R.

*A. klamathensis*, region about Klamath R. and L.

## CAMBARUS,

Distribution limited to Atlantic watershed except in Mexico.

The following natural groups of the crayfishes of Eastern North America are recognized :

- 1 First pair of abdominal appendages of the male clavate ; the outer part truncate at the tip and provided with one to three curved teeth ; the inner part terminated by a short acute curved spine.

Third segment of third and fourth pairs of legs of males hooked.

(" Group I " of Faxon)

<i>C. blandingii</i> , N. Y. to Ala.	<i>C. spiculifer</i> , Ga.
<i>C. blandingii acutus</i> , Ala., Tex., Ind.	<i>C. versutus</i> , Ala., Fla.
<i>C. fallax</i> , Fla.	<i>C. alleni</i> , Fla.
<i>C. hayi</i> , Miss.	<i>C. evermanni</i> , Fla.
<i>C. clarkii</i> , Tex. to Fla.	<i>C. barbatus</i> , Ga.
<i>C. troglodytes</i> , Ga. to S. Car.	<i>C. wiegmanni</i> , Mex.
<i>C. lecontei</i> , Ala., Ga.	<i>C. pellucidus</i> , Ind., Ky. (Caves).
<i>C. angustatus</i> , Ga.	<i>C. pellucidus testii</i> , Ind. (Caves).
<i>C. pubescens</i> , Ga.	<i>C. acherontis</i> , Fla. (Caves).

Third segment of third pair of legs of males hooked.

(" Group II " of Faxon)

<i>C. simulans</i> , Tex., Kan.	<i>C. carinatus</i> , Mex.
<i>C. mexicanus</i> , Mex.	* <i>C. cubensis</i> , Cuba.
<i>C. advena</i> , S. Ga.	<i>C. carolinus</i> , S. Car., Tex.
<i>C. gracilis</i> , Ind., Ill., Mo. (?)	(?) <i>C. clypeatus</i> , S. Miss.

- 2 First pair of abdominal appendages of the male terminated with two falcate teeth, the larger of which belongs to the outer part of the appendage, the smaller to the inner part. Third segment of third pair of legs of males hooked.

(" Group III " of Faxon)

<i>C. bartonii</i> , N. B., Mo., N. C., Tenn.	<i>C. girardianus</i> , N. Ala.
<i>C. bartonii robustus</i> , Dom. Can., Ill.	<i>C. extraneus</i> , N. Ga.
<i>C. longulus</i> , Va., N. C., Tenn.	<i>C. jordani</i> , N. Ga.
** <i>C. longulus longirostris</i> , Va., Ala., Tenn.	<i>C. argillicola</i> , Dom. Can., N. C., La.
<i>C. dubius</i> , W. Va., Tenn.	<i>C. diogenes</i> , N. J., Wy., Miss.
<i>C. uhleri</i> , Md. (" eastern shore ")	<i>C. diogenes ludovicianus</i> , La.
<i>C. latimanus</i> , S. C., Tenn., Miss.	<i>C. cornutus</i> , Ky.
<i>C. acuminatus</i> , S. C., N. C.	<i>C. hamulatus</i> , Nickajack Cave.
	<i>C. setosus</i> , Caves in S. W. Mo.

\* *C. cubensis* = *C. consobrinus* Sauss.

\*\* = *C. bartonii longirostris* Fax.

- 3 First pair of abdominal appendages of the males furciform, terminating in two elongated nearly straight, acute tips. Third segment of third pair of legs of males hooked. ("Group IV" of Faxon)

<i>C. lancifer</i> , Miss., Ark.	<i>C. mississippiensis</i> , Miss.
<i>C. affinis</i> , S. N. Y., Va., L. Superior.	<i>C. palmeri</i> , Tenn., Ind. Terr.
<i>C. indianensis</i> , S. Ind.	<i>C. palmeri longimanus</i> , Ind. Terr., Tex.
<i>C. sloanii</i> , S. Ind., Ky.	
<i>C. propinquus</i> , Dom. Can., Minn.	<i>C. longidigitus</i> , Ark.
<i>C. propinquus obscurus</i> , N. Y., Pa.	<i>C. difficilis</i> , Ind. Terr., Ark.
<i>C. propinquus sanbornii</i> , Ky., Ohio.	<i>C. meekii</i> , Ark.
<i>C. neglectus</i> , Kan., Mo.	<i>C. erichsonianus</i> , Tenn., Ala.
<i>C. harrisonii</i> , Mo.	<i>C. alabamensis</i> , N. Ala.
<i>C. virilis</i> , Dom. Can., Tex., Kan.	<i>C. compressus</i> , N. Ala.
<i>C. immunis</i> , N. Y., Wy., Tex.	<i>C. medius</i> , Mo.
<i>C. immunis spinirostris</i> , Tenn., Neb.	<i>C. rusticus</i> , Pa., Ia., Tex.
<i>C. hylas</i> , Mo.	<i>C. spinosus</i> , S. C., N. Ala.
<i>C. pilosus</i> , Kan.	<i>C. putnami</i> , Ky., Ind.
<i>C. nais</i> , Kan.	<i>C. forceps</i> , N. Ala., Va., Tenn.
	<i>C. digueti</i> , Mex.

Third segment of second and third pairs of legs of males hooked.

("Group V" of Faxon)

<i>C. montezumæ</i> , Mex.	<i>C. montezumæ occidentalis</i> , Mex.
<i>C. montezumæ dugesii</i> , Mex.	<i>C. shufeldtii</i> , La.
<i>C. montezumæ areolatus</i> , Mex.	<i>C. chapalanus</i> , Mex.

*Astacus*.—Last thoracic somite bearing a gill on each side, thus making eighteen gills (plus two or three rudiments) in each branchial chamber. Orifice of green gland on posterior face of tubercle. First abdominal appendages of males neither toothed nor bifid at the apex and none of the thoracic legs with hooks. Annulus ventralis represented by a transverse ridge.

- |   |  |                               |
|---|--|-------------------------------|
| 1 | Margins of rostrum denticulate . . . . .                                   | 2                             |
| 1 | Margins of rostrum smooth . . . . .  | 3                             |
| 2 | Chelæ with a patch of soft setæ on outer face . . . . .                    | <i>A. gambelli</i> Gir.       |
| 2 | Chelæ naked on outer face . . . . .  | <i>A. nigrescens</i> Stimp.   |
| 3 | Postorbital ridges with a posterior spine or tubercle . . . . .            | 4                             |
| 3 | Postorbital ridges without a posterior spine or tubercle . . . . .         |                               |
|   |  | <i>A. klamathensis</i> Stimp. |
| 4 | Acumen longer than distance between lateral teeth of rostrum . . . . .     |                               |
|   |  | <i>A. leniusculus</i> Dana    |
| 4 | Acumen not longer than distance between lateral teeth of rostrum . . . . . |                               |
|   |  | <i>A. trowbridgii</i> Stimp.  |

*Cambarus*.—Last thoracic segment without a gill, thus reducing the number in each branchial chamber to seventeen. Orifice of green gland at apex of tubercle. First abdominal appendages of males bifid and hooked or toothed at the apex. One or more pairs of thoracic legs of males with a hook-like tubercle on the third segment. In the females, annulus ventralis developed as a depressed cone on the sternum between the bases of the last pairs of legs.

- |    |   |                                   |
|----|---|-----------------------------------|
| 1  | Eyes normally developed . . . . .   | 2                                 |
| 1  | Eyes atrophied . . . . .  | 84                                |
| 2  | Areola very narrow or obliterated . . . . .   | 3                                 |
| 2  | Areola of moderate or excessive width . . . . .   | 18                                |
| 3  | Rostrum with lateral spines . . . . .   | 4                                 |
| 3  | Rostrum without lateral spines . . . . .  | 11                                |
| 4  | Rostrum excessively lengthened, the posterior portion of carapace one-third as long as anterior . . . . .   | <i>C. laucifer</i> Hag.           |
| 4  | Rostrum not excessively lengthened, posterior portion of carapace more than one-third as long as anterior . . . . .                                   | 5                                 |
| 5  | Rostrum with a low median longitudinal carina . . . . .   | <i>C. palmeri</i> Fax.            |
| 5  | Rostrum without a carina . . . . .  | 6                                 |
| 6  | Sides of carapace coarsely granulate; inner finger of chelæ markedly sinuate . . . . .  | 81                                |
| 6  | Sides of carapace slightly granulate or smooth . . . . .  | 7                                 |
| 7  | Areola obliterated for at least a portion of its length . . . . .   | 8                                 |
| 7  | Areola not obliterated at any point . . . . .   | 9                                 |
| 8  | First abdominal appendages of males with slender, nearly straight, acute tips. Annulus ventralis of females with a pronounced central fossa . . . . . | <i>C. palmeri longimanus</i> Fax. |
| 8  | First abdominal appendages of males with short recurved tips. Annulus ventralis of females with the central fossa almost obliterated . . . . .        | <i>C. difficilis</i> Fax.         |
| 9  | Lateral teeth of rostrum small . . . . .  | <i>C. nais</i> Fax.               |
| 9  | Lateral teeth of rostrum strong . . . . .   | 10                                |
| 10 | Anterior border of carapace angulated below the eye . . . . .   | <i>C. longidigitus</i> Fax.       |
| 10 | Anterior border of carapace not angulated . . . . .   | <i>C. pilosus</i> Hay             |
| 11 | Base of rostrum not foveolate . . . . .   | <i>C. advena</i> LeC.             |
| 11 | Base of rostrum with a more or less pronounced foveola . . . . .  | 12                                |
| 12 | Anterior border of carapace angulated below the eye . . . . .   | 13                                |
| 12 | Anterior border of carapace not angulated below the eye . . . . .   | 15                                |
| 13 | Areola linear but not obliterated . . . . .   | <i>C. gracilis</i> Bun.           |
| 13 | Areola obliterated in the middle . . . . .  | 14                                |
| 14 | Sides of rostrum straight . . . . .   | <i>C. diogenes</i> Gir.           |

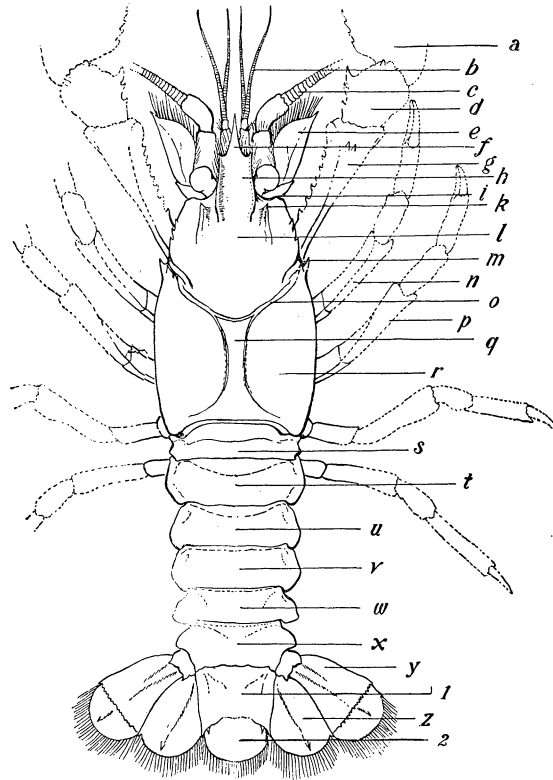
- 14 Sides of rostrum concave . . . *C. diogenes ludovicianus* Fax.  
 15 Areola linear but not obliterated . . . . . 16  
 15 Areola obliterated in the middle . . . . . 17  
 16 Rostrum short, slightly longer than broad . . . *C. carolinus* Erich.  
 16 Rostrum twice as long as broad . . . *C. mississippiensis* Fax.  
 17 Upper surface of rostrum plane and faintly carinate *C. uhleri* Fax.  
 17 Upper surface of rostrum excavated, not carinate *C. argillicola* Fax.  
 18 Rostrum with lateral teeth . . . . . 19  
 18 Rostrum without lateral teeth . . . . . 63  
 19 Sides of carapace with two spines just behind the cervical groove . 20  
 19 Sides of carapace with only one spine or unarmed . . . . . 21  
 20 Proximal segment of telson with three or four spines on each side of  
     the posterior border . . . . . *C. versutus* Hag.  
 20 Proximal segment of telson with only two spines  
     *C. spiculifer* LeC.  
 21 Rostrum with a more or less pronounced median longitudinal carina  
     above . . . . . 22  
 21 Rostrum without a carina . . . . . 29  
 22 Proximal segment of telson with three spines on each side  
     *C. carinatus* Fax.  
 22 Proximal segment of telson with only two spines on each side . . 23  
 23 Sides of carapace with a spine . . . . . 24  
 23 Sides of carapace unarmed . . . . . *C. compressus* Fax.  
 24 Outer finger of chela bearded at base on inner margin . . . 25  
 24 Outer finger of chela not bearded . . . . . 26  
 25 Rostrum slightly excavated, carina broad, low, and rounded  
     *C. alabamensis* Fax.  
 25 Rostrum deeply excavated, carina very faint . . . *C. meeki* Fax.  
 26 Rostrum slightly excavated (broad and nearly plane above)  
     *C. neglectus* Fax.  
 26 Rostrum well excavated (narrower and deeply grooved) . . . 27  
 27 Postorbital spine strong . . . . . *C. meeki* Fax.  
 27 Postorbital spine weak . . . . . 28  
 28 Rostrum with a low carina . . . . . *C. propinquus* Gir.  
 28 Rostrum with a high, sharp carina . . . . . *C. digneti* Bouv.  
 29 Flagellum of antenna excessively flattened and heavily ciliate along the  
     inner margin . . . . . *C. cornutus* Fax.  
 29 Flagellum of antenna normal . . . . . 30  
 30 Carapace without lateral spines . . . . . 31  
 30 Carapace with lateral spines . . . . . 39  
 31 Sides of rostrum straight or concave . . . . . 32  
 31 Sides of rostrum convex . . . . . 34  
 32 Postorbital spines small or wanting . . . . . *C. virilis* Hag.  
 32 Postorbital spines well developed . . . . . 33  
 33 Areola broader . . . . . *C. rusticus* Gir.

- 33 Areola narrower . . . . . *C. meeki* Fax.  
 34 Postorbital spines wanting . . . . . 35  
 34 Postorbital spines present . . . . . 36  
 35 Sides of rostrum converging uniformly to the apex, no acumen  
     *C. montezumæ occidentalis* Fax.  
 35 Sides of rostrum angulated or slightly toothed near the apex, thus defining an acumen . . . . . *C. montezumæ* Sauss.  
 36 Rostrum long and slender, with stout, sharp lateral spines and slender acumen ; postorbital spines strong . . . . . *C. chapalanus* Fax.  
 36 Rostrum of medium length, with small lateral teeth and short, broad acumen ; postorbital spines small . . . . . 37  
 37 Sides of rostrum raised as sharp ridges . . . . . *C. montezumæ dugesii* Fax.  
 37 Sides of rostrum not raised as sharp ridges . . . . . 38  
 38 Branchiostegal spine not developed . . . . . *C. montezumæ areolatus* Fax.  
 38 Branchiostegal spine developed but small . . . . . *C. cubensis* Erich.  
 39 Posterior portion of carapace considerably less than half as long as anterior portion . . . . . 40  
 39 Posterior portion of carapace half or nearly half as long as anterior portion . . . . . 42  
 40 Areola wide . . . . . 41  
 40 Areola rather narrow . . . . . *C. lecontei* Hag.  
 41 Proximal segment of telson with three spines on each side  
     *C. angustatus* LeC.  
 41 Proximal segment of telson with four spines on each side  
     *C. pubescens* Fax.  
 42 Anterior border of carapace with a projecting angle below the eye . 43  
 42 Anterior border of carapace not angulated . . . . . 54  
 43 Suborbital angle spinulose . . . . . 82  
 43 Suborbital angle not spinulose . . . . . 44  
 44 Rostrum nearly plane above . . . . . 45  
 44 Rostrum well excavated . . . . . 46  
 45 Acumen long . . . . . *C. jordani* Fax.  
 45 Acumen rather short (size small) . . . . . *C. shufeldtii* Fax.  
 46 Areola narrow . . . . . 47  
 46 Areola of moderate or excessive width . . . . . 48  
 47 Margins of rostrum concave . . . . . *C. meeki* Fax.  
 47 Margins of rostrum slightly convex . . . . . *C. immunis spinirostris* Fax.  
 48 Areola wide . . . . . *C. sloanii* Bun.  
 48 Areola of moderate width . . . . . 49  
 49 Acumen of rostrum short . . . . . 50  
 49 Acumen of rostrum not short . . . . . 51  
 50 Lateral teeth of rostrum well developed but short, sides of rostrum nearly parallel . . . . . *C. blandingii* Har.  
 50 Lateral teeth of rostrum poorly developed, sides of rostrum convergent  
     *C. blandingii acutus* Gir.



- 51 Anterior portion of carapace a very little more than twice as long as anterior portion . . . . . *C. spinosus* Bun.
- 51 Anterior portion of carapace not more than twice as long as posterior portion . . . . . 52
- 52 Rostrum faintly carinate . . . . . *C. forceps* Fax.
- 52 Rostrum not carinate . . . . . 53
- 53 Acumen of moderate length . . . . . *C. hylas* Fax.
- 53 Acumen long and slender . . . . . *C. putnami* Fax.
- 54 Sides of rostrum concave . . . . . 55
- 54 Sides of rostrum not concave . . . . . 57
- 55 Lateral spines of carapace strong . . . . . *C. indianensis* Hay
- 55 Lateral spines of carapace small or obsolete . . . . . 56
- 56 Postorbital spines well developed . . . . . *C. harrisonii* Fax.
- 56 Postorbital spines small or obsolete . . . . . *C. rusticus* Gir.
- 57 Lateral spines of carapace strong . . . . . 58
- 57 Lateral spines of carapace small and weak . . . . . 60
- 58 Sides of rostrum nearly parallel, acumen long and rather slender . 59
- 58 Sides of rostrum convergent, acumen short . . . . . *C. hayi* Fax.
- 59 Postorbital spines strong, sides spiny . . . . . *C. affinis* Say.
- 59 Postorbital spines small, sides not spiny . . . . . *C. erichsonianus* Fax.
- 60 Proximal segment of telson with three or four spines on each side  
*C. fallax* Hag.
- 60 Proximal segment of telson with only two spines on each side . . 61
- 61 Rostrum deeply excavated . . . . . *C. propinquus sanbornii* Fax.
- 61 Rostrum slightly excavated or subplane . . . . . 62
- 62 Tip of acumen abruptly turned upward . . . . . *C. virilis* Hag.
- 62 Tip of acumen gently curved upward . . . . . *C. obscurus* Hag.
- 63 Carapace with one spine on each side just behind cervical groove . 64
- 63 Carapace without lateral spines . . . . . 67
- 64 Postorbital and branchiostegal spines well developed . . . . . 65
- 64 Postorbital and branchiostegal spines small or wanting . . . . . 66
- 65 Areola narrow . . . . . *C. wiegmanni* Erich.
- 65 Areola broad . . . . . *C. acuminatus* Fax.
- 66 Base of rostrum slightly foveolate . . . . . *C. immunis* Hag.
- 66 Base of rostrum not foveolate . . . . . *C. virilis* Hag.
- 67 Branchiostegal spine developed . . . . . 68
- 67 Branchiostegal spine wanting . . . . . 74
- 68 Anterior border of carapace decidedly angulated below the eye . 69
- 68 Anterior border of carapace hardly angulated . . . . . 73
- 69 Proximal segment of telson with three or four spines on each side . 70
- 69 Proximal segment of telson with only two spines on each side . 71
- 70 Rostrum pubescent and nearly flat above . . . . . *C. mexicanus* Erich.
- 70 Rostrum not pubescent, deeply excavated . . . . . *C. alleni* Fax.
- 71 Inner surface of hands with a more or less thick covering of soft setæ  
*C. barbatus* Fax.

- 71 Inner surface of hands not setose . . . . . 72  
 72 Cervical groove broken on the sides . . . . . *C. virilis* Hag.  
 72 Cervical groove not broken on the sides . . . . . *C. latimanus* Erich.  
 73 Areola carinate . . . . . *C. simulans* Fax.  
 73 Areola not carinate . . . . . 83



Outline drawing of *Cambarus affinis* ♂ showing most of the structures mentioned in the diagnosis of the species of crayfishes. *a*, chela; *b*, 1st antenna (antennules); *c*, 2d antenna (antenna); *d*, carpus (of chelaped); *e*, antennal scale; *f*, acumen (of rostrum); *g*, meros (of chelaped); *h*, rostrum; *i*, suborbital angle; *k*, postorbital spine and ridge; *l*, anterior (gastric) portion of carapace; *m*, lateral spine (of carapace); *n*, second pair of legs; *o*, cervical groove; *p*, third pair of legs; *q*, areola; *r*, posterior (branchio-cardiac) portion of carapace; *s*, *t*, *u*, *v*, *w*, *x*, segments of abdomen; *y*, *z*, outer and inner blades of caudal fin; *1*, *2*, proximal and distal segments of telson.

- 74 Rostrum with a longitudinal median carina above . . . . . *C. medius* Fax.  
 74 Rostrum not carinate . . . . . 75  
 75 Rostrum deeply excavated . . . . . 76  
 75 Rostrum not deeply excavated . . . . . 77  
 76 Rostrum strongly decurved, areola narrow . . . . . *C. dubius* Fax.

- 76 Rostrum not strongly decurved, areola not narrow . . . *C. virilis* Hag.  
 77 Rostrum long, antennal scale long and broad . . . *C. montezumæ* Sauss.  
 77 Rostrum short, antennal scale short and narrow . . . . . 78  
 78 Edges of rostrum swollen and raised, fingers gaping widely at base,  
     outer finger more or less bearded within at base . . . . . 79  
 78 Edges of rostrum not swollen, fingers not widely gaping at base, outer  
     finger not bearded . . . . . 80  
 79 Spines of postorbital ridges weak ; suborbital angle not produced  
     . . . . . *C. longulus* Gir.  
 79 Spines of postorbital ridges strong ; suborbital angle produced, almost  
     spiniform . . . . . *C. longulus longirostris* Fax.  
 80 Carapace depressed, sides gently curving toward front and rear ; hands  
     not impressed . . . . . *C. bartonii* Fab.  
 80 Carapace cylindrical, sides nearly parallel as far forward as cervical  
     groove, then curving abruptly to base of rostrum. Hands strongly  
     impressed . . . . . *C. bartonii robustus* Gir.  
 81 Rostrum of medium length, well excavated, lateral teeth strong  
     . . . . . *C. clarkii* Gir.  
 81 Rostrum short, almost flat above, lateral teeth small  
     . . . . . *C. troglodytes* LeC.  
 82 Distal end of meros with one small spine on superior surface  
     . . . . . *C. girardianus* Fax.  
 82 Distal end of meros with two strong spines on superior surface  
     . . . . . *C. extraneus* Hag.  
 83 Proximal segment of telson with two spines on each side  
     . . . . . *C. evermanni* Fax.  
 83 Proximal segment of telson with four or more spines on each side  
     . . . . . *C. clypeatus* Hag.  
 84 Areola broad and long, with parallel sides ; carapace nearly smooth,  
     very lightly granulate on the sides . . . . . 85  
 84 Areola narrow, with curved sides ; carapace roughly granulate on the  
     sides at least . . . . . 87  
 85 Rostrum foveolate at base . . . . . *C. hamulatus* Cope and Pack.  
 85 Rostrum not foveolate . . . . . 86  
 86 Sides of carapace spiny . . . . . *C. pellucidus* Tellk.  
 86 Sides of carapace unarmed . . . . . *C. pellucidus testii* Hay  
 87 Sides of carapace granulate and setose ; no lateral or postorbital spines ;  
     areola very narrow . . . . . *C. setosus* Fax.  
 87 Sides of carapace tuberculate ; lateral and postorbital spines developed ;  
     areola linear . . . . . *C. acherontis* Lönn.